Forest Health Protection

Pacific Southwest Region
Northeastern California Shared Service Area

Date: June 17, 2022
File Code: 3420

To: District Ranger, Yuba River RD, Tahoe NF

Subject: Managing Heterobasidion Root Disease (HRD) in the Galloway Project (FHP Report NE 22-05). (Lat 39.521429 Lon -120.849822)

Overview:
On November 29, 2021, Roger Brown (YRRD Silviculturist) and Bill Woodruff (R5 FHP Plant Pathologist) examined five proposed units in the Galloway Project ("Galloway Project" Map: "Eval stops"). Heterobasidion root disease (HRD) pathogen *Heterobasidion occidentale* was found to be infecting white fir (WF) trees in proposed unit numbers: 150, 151, 74, 71 and 45. In addition, while driving through other proposed units, HRD symptoms were observed on overstory and understory WF, as well. Harvesting WF suspected of having HRD and retaining and/or regenerating non-host conifers should reduce the impact of HRD in affected stands.

Figure1

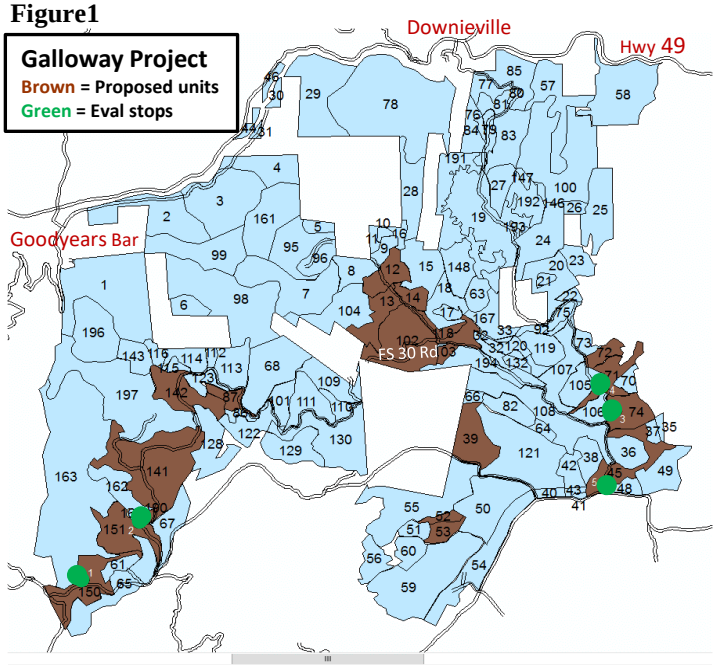


Figure 2. HRD characteristic delaminated wood and stump decay.

HRD Signs and Symptoms:
The presence of HRD in the Project area was confirmed by finding delaminated WF wood and characteristic decay in WF stumps (Figure 2). Also older dead *H. occidentale* fruiting bodies were found.

WF trees with HRD symptoms were seen in all units visited and along the roads traveled. HRD symptoms found in the Galloway Project area are:

1) WF overstory and understory trees with unexplained rounded tops and/or dead tops are symptoms of

Danny Cluck
Forest Entomologist
530-708-2770
daniel.cluck@usda.gov

Bill Woodruff
Plant Pathologist
530-249-7990
william.woodruff@usda.gov

HRD (Figure 3). A rounded WF top indicates that the WF tree's height growth had been reduced for a long time because water and nutrients are not getting to terminal buds. *H. occidentale* can restrict water and nutrient movement into WF roots for transport throughout the tree. Poor soil, overstocked trees, other diseases or extended drought can also cause WF to have reduced height growth and rounded tops. If these are not present, then HRD is likely the cause.

2) WF overstory trees with unexplained dead branches, crown fade or thin foliage are also symptoms of HRD (Figure 4). WF branches infected with WF dwarf mistletoe (*Arceuthobium abietinum var. concolor*) can be killed by the canker forming fungus *Cytospora abietis* with or without HRD in the roots. In the left WF tree in Figure 4, the branch mortality in the top is due to *C. abietis* infecting dwarf mistletoe wounds; whereas the lower dead branches are mostly caused by HRD.

Figure 4. Dead branches (left), thin foliage (right) and round tops (both) are probably caused by HRD. The dead foliage in the WF top (left) is from *Cytospora abietis* killing branches weakened by dwarf mistletoe. The dead branches in the lower crown (left) are caused by HRD because these branches have no symptoms of dwarf mistletoe (swollen branches and witches' brooms).

3) When a mixed conifer forest without HRD is stressed, mortality occurs in scattered WF trees. Groups of dead WF (Figure 5) usually occur in HRD centers. A forest with numerous groups of dead WF trees and top-killed WF indicates HRD is widespread.

Figure 3. HRD-stressed WF trees with rounded tops. The top on the left tree is dying from beetles attacking a WF weakened by HRD. The WF snag (left) is a WF tree, likely with HRD, which was preferentially attacked and killed by beetles.

Figure 5. Group of five dead WF in a HRD center.

White pine blister rust:

White pine blister rust (WPBR) caused by the fungus *Cronartium ribicola* is present in the Galloway Project area (Figure 6). Sugar pine (SP) of all ages are infected. Usually badly infected merchantable sugar pine should be removed. Defective SP with WPBR may be retained if they are otherwise beneficial; to wildlife, for example.

It is recommended to plant WPBR resistant SP seedlings in places WPBR is present, like the Galloway Project area. Where understory trees are thinned, all SP seedlings, saplings and poles-sized trees with WPBR should be cut.

Figure 6. White pine blister rust infecting sugar pine seeding (left) and overstory sugar pine (right).

Managing HRD:

HRD is present throughout the Project area. The impact of HRD is reduced in places where WF trees are surrounded with conifers unaffected by the disease. Much of the Project is a mixed conifer forest with similar numbers of Doug-fir (DF) and WF trees mixed with lesser numbers of ponderosa/Jeffrey pine (PP/JP), incense cedar (IC) and sugar pine. DF, PP/JP, IC and SP are unaffected by HRD. Even though DF, IC and SP can be infected by *H. occidentale*, HRD has not been found to be damaging to or a problem on these species in NE CA.

To manage HRD in the Galloway Project, it is recommended to remove WF trees and groups of WF trees (Figure 7) exhibiting HRD symptoms (i.e. dead trees, dead tops, thinning or declining crowns). In addition, reducing tree densities around healthy-appearing HRD WF will increase resilience and vigor in those trees. Openings created when harvesting WF groups or stands can be regenerated with DF, PP/JP, IC or WPBR resistant SP.

Figure 7. WF stand in proposed Unit #74 heavily impacted by HRD with typical HRD symptoms (i.e. dead trees, dead tops, thinning or declining crowns). To manage HRD, this stand could be regenerated with trees not affected by HRD.

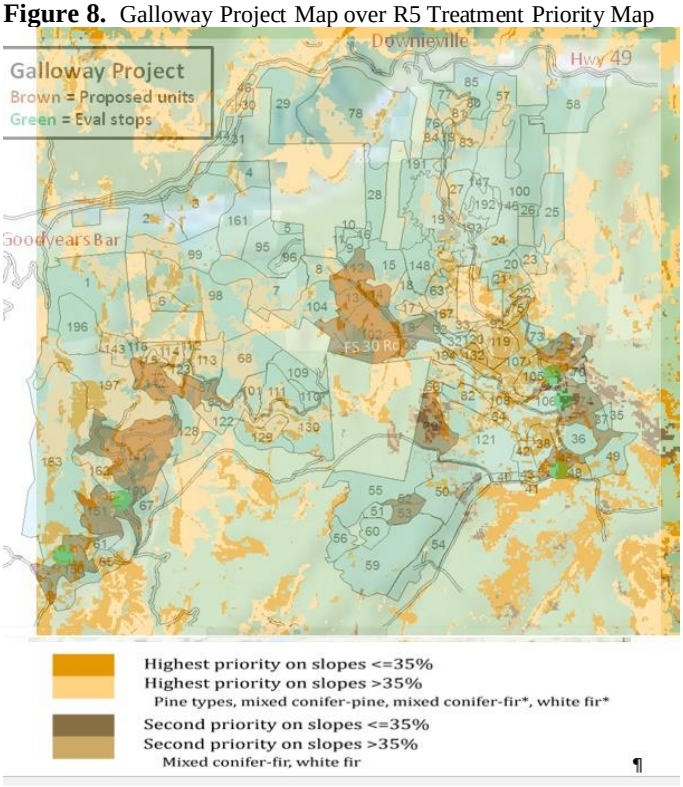
Priority treatment areas & wildfire threat:

Overlaying the Galloway Project Map on the R5 Treatment Priority Map (Figure 8) shows that the proposed Galloway Project will treat many highest and second priority polygons in need of treatment; thereby improving forest health.

Managing densities in the proposed units (Figure 1) with the sole purpose of preventing future drought mortality and/or insect and disease mortality will not protect them from being destroyed by wildfire. Most

blue and brown units in Figure 1 have tree densities and understories capable of sustaining wildfire. Figure 9 shows one view of dense trees positioned below and around the proposed Project units. There are approximately ten thousand acres of forest at risk to wildfire surrounding the Galloway proposed units. A large portion of the Galloway Project area is a second growth forest that resulted from a wildfire which started near Goodyears Bar over a century ago and burned thousands of acres; proving that another large wildfire is possible. The Galloway area is at risk of burning again.

Figure 8. Galloway Project Map over R5 Treatment Priority Map



To protect the Galloway Project proposed units from wildfire, low tree densities in much of the area (shown in Figure 1) should be strategically manipulated so that future wildfires will burn on the ground and not through the crowns. Until this happens, all forest management done in a few stands could be undone by future wildfires.

Significantly lowering tree densities in the Galloway Project area, in addition to reducing the threat of forest destroying wildfire, will reduce the impacts of drought, HRD, insects and other diseases [See FHP report #NE22-02 – Managing Heterobasidion Root Disease (HRD) in Greene Acres Project-March 17, 2022].

Please refer questions to Bill Woodruff

/s/ *Bill Woodruff*
Bill Woodruff
Plant Pathologist
NE CA FHP Shared Service Area

cc. R5 FHP, Roger Brown

Figure 9. Tree densities in Galloway Project area capable of sustaining wildfire.

Appendix A: Pest Biologies

Heterobasidion root disease (HRD)

Heterobasidion spp. is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (*Arbutus menziesii*), and a few brush species (*Arctostaphylos spp.* and *Artemisia tridentata*) are occasional hosts. Other hardwood species are apparently not infected. HRD has been reported on all National Forests in California, with incidence particularly high on true fir in northern California, in the eastside pine type forests, and in southern California recreation areas.

HRD is one of the most important conifer diseases in US Forest Service Region 5, California. Current estimates are that the disease infests about 2 million acres of commercial forestland in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of HRD include increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future wood production, and depletion of vegetative cover and increased probability of tree failure and hazard in recreation areas.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New HRD infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds, or occasionally, through roots of stumps in the absence of surface colonization. From the infected stump surface, the fungus grows down into the roots and then spreads via root-to-root contact to adjacent live trees, resulting in the formation of large HRD centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant trees. In pines, the fungus grows through root cambial tissue to the root crown where it can girdle and kill the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood and sapwood of the lower trunk and causes chronic decay, restricted water movement and growth loss.

Heterobasidion root disease in western North America is caused by two species: *Heterobasidion occidentale* and *H. irregulare*. These two species of *Heterobasidion* have major differences in host specificity. *H. irregulare* is pathogenic on ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense cedar, western juniper, pinyon, and manzanita. *H. occidentale* is pathogenic on true fir, spruce, and giant sequoia. This host specificity is not apparent in isolates from stumps; with *H. occidentale* being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.

Dwarf mistletoe

Dwarf mistletoes (*Arceuthobium* spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are then forcibly discharged from the fruit. Seed are covered with a sticky substance and adhere to whatever they contact. When a seed lands in a host tree crown, it usually sticks to a needle, from where it can be moved to the twig by rain or snow. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues. It develops a root-like system within the inner bark and outer sapwood and causes the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seed is limited to the distance the seeds travel after being discharged; from overstory to understory, this is usually 20 to 60 feet, but wind may carry dwarf mistletoe seed more than 100 feet from the source. A rule of thumb is that seed can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occasionally vectored by birds and mammals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. Because of the thin crowns of gray pine, however, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equaled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow green to orange mistletoe plants, basal cups on a branch where the plants were attached, and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.

Cytospora Canker

Cytospora abietis is a canker-causing fungus that infects true firs throughout their range in California. *C. abietis* is a weak parasite, and usually attacks trees that have been weakened by disease, drought, fire, insects, or human disturbance. Cytospora is commonly associated with dwarf mistletoe infection, and sometimes attacks as many as a quarter of the mistletoe-bearing branches, killing many each year. The bright red flags of recently killed branches on dwarf mistletoe-infected white and red firs are almost always the result of lethal Cytospora infections. *C. abietis* can occasionally be especially damaging in some years, infecting trees of any age. *C. abietis* can kill young true fir trees or their tops.

White Pine Blister Rust (WPBR)

White pine blister rust, caused by the fungal pathogen *Cronartium ribicola*, is an exotic, invasive disease that is native to Asia. WPBR was introduced to both the east and west coasts of the United States in the early 1900s in infected white pine nursery stock imported from Europe.

WPBR has a complex life cycle that requires alternate hosts for survival and spread of the disease. The life cycle includes five spore stages that most commonly alternate between five-needle pines and currant or gooseberry (*Ribes* spp.) leaves; although Indian paintbrush and a few other plants have recently been determined to serve as alternate hosts as well. All five-needle pines are susceptible to the fungus, although some species are more susceptible than others. Of the species native to North America, western white pine, sugar pine, eastern white pine and whitebark pine are most susceptible; limber pine and southwestern white pine are moderately susceptible. The susceptibility of bristlecone pine is under investigation.

WPBR is an important exotic pathogen of forest trees worldwide, and has been particularly devastating to large forested areas and forest stand structure in North America.

Distribution
After introduction from Europe on both coasts of the United States, the pathogen spread throughout the entire range of white pines in North America. Although less of a problem in the East, the disease is found from the Atlantic Provinces of Canada south through Georgia and as far west as Minnesota and Iowa. In Western North America, the pathogen is infecting white pine species from British Columbia and Alberta through the Intermountain West and Pacific Northwest, south through the Rocky Mountain Region, California, and the Southwest, and into Mexico, and is actively continuing its spread in elevation and latitude. It is most severe where conditions are cool and moist for extended periods in late summer and early fall.

Damage
Seedlings and saplings are more susceptible to infection by *C. ribicola* than older trees because the microclimate surrounding them is usually more favorable for infection. If spores are present and conditions are optimal, seedlings may become infected during the first growing season. Some seedling mortality may occur in the second year or later. Blister rust is a major cause of mortality in out-planted five-needle pines, making reestablishment of these species extremely difficult. Rust resistant sugar pine seedings are available in California for planting in areas at risk to WPBR.